Problems on Voice over IP (VoIP)

Problem 1

The following trace refers to the regostration phase of a SIP user. Answer the following questions:

1. What is the IP address of the SIP client?
2. What is the IP address of the SIP proxy?
3. Why the first registration attempt does fail?
4. provide a brief explanation of the whole registration process

N.	Network	Transport	Application
1	IP: 130.192.225.36 => 130.192.225.79 (Len 60)	UDP: port 4136 => 53	DNS Query
2	IP: 130.192.225.79 => 130.192.225.36 (Len 328)	UDP: port 53 => 4136	DNS Response
3	IP: 130.192.225.36 => 130.192.225.79 (Len 601)	UDP: port 63772 => 5060	SIP: REGISTER sip:ipv6.polito.it SIP/2.0
4	IP: 130.192.225.79 => 130.192.225.36 (Len 728)	UDP: port 5060 => 63772	SIP: SIP/2.0 401 Unauthorized
5	IP: 130.192.225.36 => 130.192.225.79 (Len 800)	UDP: port 63772 => 5060	SIP: REGISTER sip:ipv6.polito.it SIP/2.0
6	IP: 130.192.225.79 => 130.192.225.36 (Len 706)	UDP: port 5060 => 63772	SIP: SIP/2.0 200 OK

Problem 1 - answers

1. The IP address of the UA SIP is 130.192.225.36
2. The IP address of the SIP proxy is 130.192.225.79
3. The first registration attempt fails because SIP UA did not include credentials for authentication in the REGISTER message
4. The registration procedure is required for
   1. Authenticating a user that tries to access a SIP domain
   2. Associating the SIP URI with the SIP UA (host) where the user is connected
      1. In this way, the user can be reached using his SIP URI
      2. If the user moves to a different IP address, he should re-register with his domain SIP server

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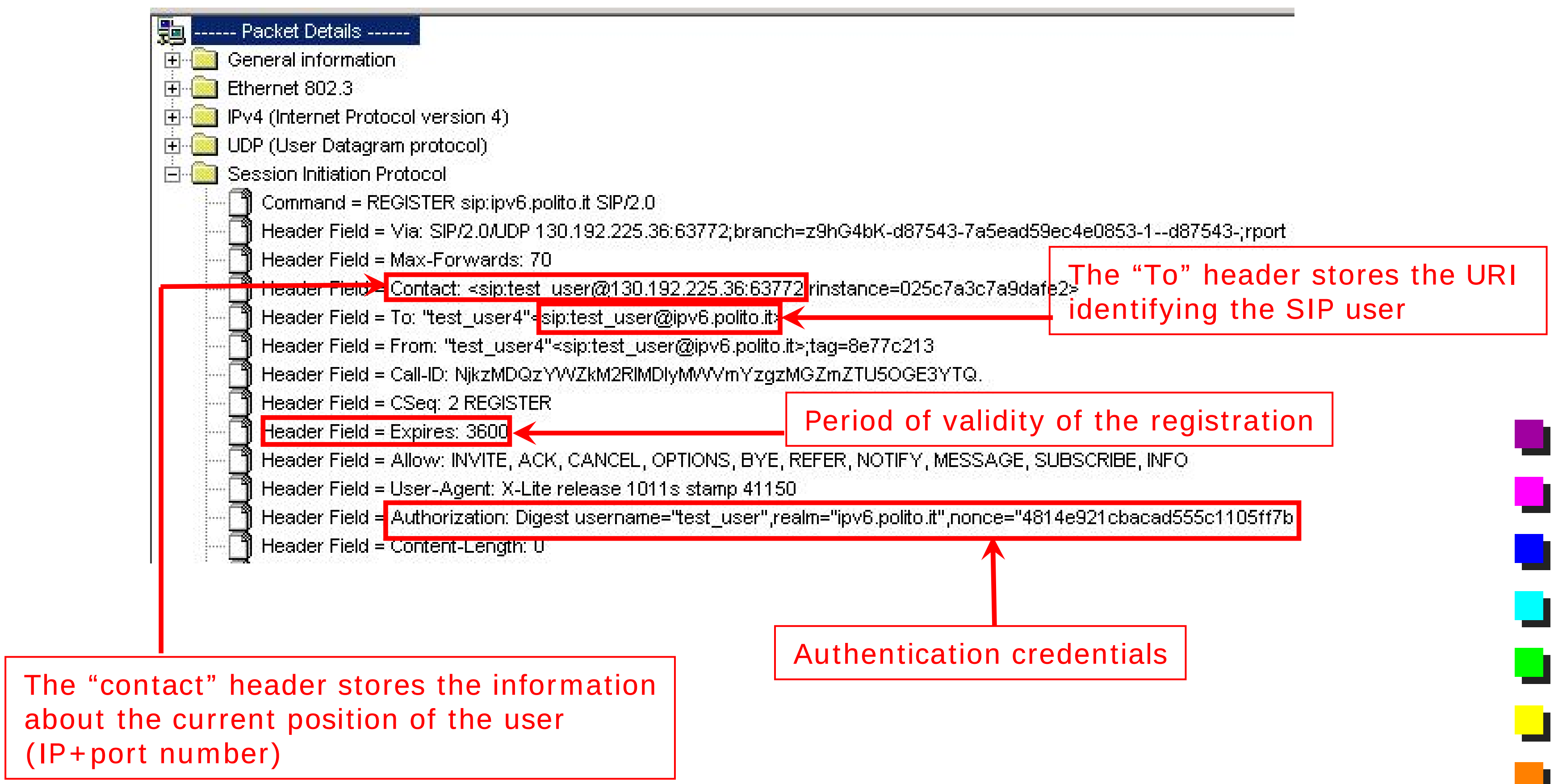
4	IP: 130.192.225.79 => 130.192.225.36 (Len 728)	UDP: port 5060 => 63772	SIP: SIP/2.0 401 Unauthorized
5	IP: 130.192.225.36 => 130.192.225.79 (Len 800)	UDP: port 63772 => 5060	SIP: REGISTER sip:ipv6.polito.it SIP/2.0
6	IP: 130.192.225.79 => 130.192.225.36 (Len 706)	UDP: port 5060 => 63772	SIP: SIP/2.0 200 OK

Problem 2

Explain the meaning and the role of the main SIP headers of the following message

```
------ Packet Details ------
+ General information
+ Ethernet 802.3
+ IPv4 (Internet Protocol version 4)
+ UDP (User Datagram protocol)
- Session Initiation Protocol
    Command = REGISTER sip:ipv6.polito.it SIP/2.0
    Header Field = Via: SIP/2.0/UDP 130.192.225.36:63772;branch=z9hG4bK-d87543-7a5ead59ec4e0853-1--d87543-;rport
    Header Field = Max-Forwards: 70
    Header Field = Contact: <sip:test_user@130.192.225.36:63772;rinstance=025c7a3c7a9dafe2>
    Header Field = To: "test_user4"<sip:test_user@ipv6.polito.it>
    Header Field = From: "test_user4"<sip:test_user@ipv6.polito.it>;tag=8e77c213
    Header Field = Call-ID: NjkzMDQzYWZkM2RlMDIyMWVmYzgzMGZmZTU5OGE3YTQ.
    Header Field = CSeq: 2 REGISTER
    Header Field = Expires: 3600
    Header Field = Allow: INVITE, ACK, CANCEL, OPTIONS, BYE, REFER, NOTIFY, MESSAGE, SUBSCRIBE, INFO
    Header Field = User-Agent: X-Lite release 1011s stamp 41150
    Header Field = Authorization: Digest username="test_user",realm="ipv6.polito.it",nonce="4814e921cbacad555c1105ff7b
    Header Field = Content-Length: 0
```

Problem 2 - solution



Problem 3

Given the following SIP REGISTER message, assuming a correct configuration for the SIP client, what could be the answer to this request?

```
------ Packet Details ------
+ General information
+ Ethernet 802.3
+ IPv4 (Internet Protocol version 4)
+ UDP (User Datagram protocol)
- Session Initiation Protocol
    Command = REGISTER sip:ipv6.polito.it SIP/2.0
    Header Field = Via: SIP/2.0/UDP 130.192.225.36:63772;branch=z9hG4bK-d87543-3f770c2abd2b875b-1--d87543-;rport
    Header Field = Max-Forwards: 70
    Header Field = Contact: <sip:test_user@130.192.225.36:63772;rinstance=025c7a3c7a9dafe2>
    Header Field = To: "test_user4"<sip:test_user@ipv6.polito.it>
    Header Field = From: "test_user4"<sip:test_user@ipv6.polito.it>;tag=8e77c213
    Header Field = Call-ID: NjkzMDQzYWZkM2RlMDlyMWVmYzgzMGZmZTU5OGE3YTQ.
    Header Field = CSeq: 1 REGISTER
    Header Field = Expires: 3600
    Header Field = Allow: INVITE, ACK, CANCEL, OPTIONS, BYE, REFER, NOTIFY, MESSAGE, SUBSCRIBE, INFO
    Header Field = User-Agent: X-Lite release 1011s stamp 41150
    Header Field = Content-Length: 0
    Header Field
```

Problem 3 - answer

Since most of the SIP server require a user to authenticate itself, the most likely answer is “401 Unauthorized”, because the message does not include credentials for the authentication.

No username – IP association will be created and the server response will include a challenge for the authentication.

Problem 4

The following is a trace of an INVITE session, assuming that the caller is in the SIP domain "ipv6.polito.it", answer the following questions:

1. What is the username of both clients?
2. What is the IP address and port number for both clients?
3. What is the meaning of the "100 Trying" messagg?
4. What is the meaning of the "180 Ringing" message?
5. Record-routing is enabled in the SIP proxy(ies)?
6. What is the minimum number of Sip proxies that can be traversed by an INVITE message?

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1	IP: 130.192.225.135 => 130.192.225.79 (Len 60)	DNS Query
2	IP: 130.192.225.79 => 130.192.225.135 (Len 328)	DNS Response
3	IP: 130.192.225.135 => 130.192.225.79 (Len 768)	SIP: INVITE sip:test_user@ipv6.polito.it SIP/2.0
4	IP: 130.192.225.79 => 130.192.225.135 (Len 604)	SIP: SIP/2.0 100 trying -- your call is important to us
5	IP: 130.192.225.79 => 130.192.225.135 (Len 481)	SIP: SIP/2.0 180 Ringing
6	IP: 130.192.225.79 => 130.192.225.135 (Len 811)	SIP: SIP/2.0 200 OK
7	IP: 130.192.225.135 => 130.192.225.79 (Len 509)	SIP: ACK sip:test_user@130.192.225.36:63772;rinstance=025c7a3c7a9da...
8	IP: 130.192.225.79 => 130.192.225.135 (Len 655)	SIP: BYE sip:livio@130.192.225.135:7226 SIP/2.0
9	IP: 130.192.225.135 => 130.192.225.79 (Len 495)	SIP: SIP/2.0 200 OK

Problem 4: answers (1/3)

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2	IP: 130.192.225.79 => 130.192.225.135 (Len 328)	DNS Response
3	IP: 130.192.225.135 => 130.192.225.79 (Len 768)	SIP: INVITE sip:test_user@ipv6.polito.it SIP/2.0
4	IP: 130.192.225.79 => 130.192.225.135 (Len 604)	SIP: SIP/2.0 100 trying -- your call is important to us
5	IP: 130.192.225.79 => 130.192.225.135 (Len 481)	SIP: SIP/2.0 180 Ringing
6	IP: 130.192.225.79 => 130.192.225.135 (Len 811)	SIP: SIP/2.0 200 OK
7	IP: 130.192.225.135 => 130.192.225.79 (Len 509)	SIP: ACK sip:test_user@130.192.225.36:63772;instance=025c7a5c7a9da...
8	IP: 130.192.225.79 => 130.192.225.135 (Len 655)	SIP: BYE sip:livio@130.192.225.135:7226 SIP/2.0
9	IP: 130.192.225.135 => 130.192.225.79 (Len 495)	SIP: SIP/2.0 200 OK

"livio"

2. **Caller address:130.192.225.135:7226**
   Called address: 130.192.225.36:63772

- **IP addresses and port numbers can be read from the messages ACK and BYE (respectively)**
- **Once the dialog is established. the two UAs can communicate directly, using the addresses and port numbers discovered during the INVITE process**

Problem 4: answers (2/3)

3. **The message "100 Trying" is sent from the proxy ato the caller UA to signal that the request has been received, and it is under process**
4. **The message "180 Ringing" is sent from the called UA to the caller one (through the proxies) to confirm the reception of the request and for notifying the caller that the called phone is now ringing**
   - Only when the human user will take the phone "off-hook" the response **200 OK** is generated

Problem 4: answers (3/3)

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2	IP: 130.192.225.79 => 130.192.225.135 (Len 328)	DNS Response
3	IP: 130.192.225.135 => 130.192.225.79 (Len 768)	SIP: INVITE sip:test_user@ipv6.polito.it SIP/2.0
4	IP: 130.192.225.79 => 130.192.225.135 (Len 604)	SIP: SIP/2.0 100 trying -- your call is important to us
5	IP: 130.192.225.79 => 130.192.225.135 (Len 481)	SIP: SIP/2.0 180 Ringing
6	IP: 130.192.225.79 => 130.192.225.135 (Len 811)	SIP: SIP/2.0 200 OK
7	IP: 130.192.225.135 => 130.192.225.79 (Len [illegible])	SIP: ACK sip:test_user@130.192.225.36:63772;rinstance=025c7a3c7a9da...
8	IP: 130.192.225.79 => 130.192.225.135 (Len 655)	SIP: BYE sip:livio@130.192.225.135:7226 SIP/2.0
9	IP: 130.192.225.135 => 130.192.225.79 (Len 495)	SIP: SIP/2.0 200 OK

5. It is possible to see that the proxy is always involved in all the SIP messages. Hence record routing is enabled.
6. Since both users belong to the same SIP domain, the minimum number of proxies traversed is 1 (it would be 2 if they were in 2 different domains)

Problem 5 (without solution)

The following is a trace of an INVITE session, assuming that the caller is in the SIP domain “ipv6.polito.it”, answer the following questions:

- What is the IP address and port number of both SIP UA?
- Is record routing enabled?

No.	Time	Source	Destination	Protocol	Info
1	0.000000	130.192.225.79	130.192.225.135	SIP/SD	Request: INVITE sip:livio@130.192.225.135:7225;
2	0.021484	130.192.225.135	130.192.225.79	SIP	Status: 180 Ringing
3	2.746769	130.192.225.135	130.192.225.79	SIP/SD	Status: 200 OK, with session description
4	2.855290	130.192.225.36	130.192.225.135	SIP	Request: ACK sip:livio@130.192.225.135:7225
5	8.651164	130.192.225.135	130.192.225.36	SIP	Request: BYE sip:test_user@130.192.225.36:7884
6	8.754173	130.192.225.36	130.192.225.135	SIP	Status: 200 OK

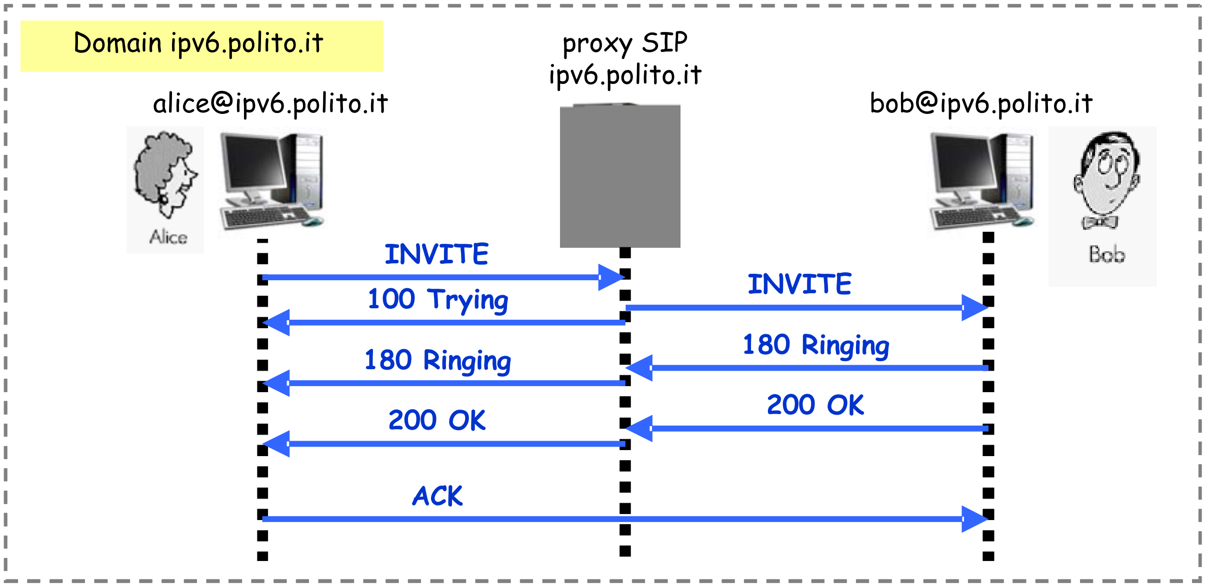
Problem 6

- **If two SIP users have the following URI correctly registered in their domain:**
  - alice@ipv6.polito.it
  - bob@ipv6.polito.it

1. **Draw a diagram with all the messages exchanged between Alice and Bob, in oder to set up a call, including:**
   1. Possible auxiliary messages
   2. Messages sent by the proxy

Problem 6 - answer

- The requested diagram is shown below
  - since the registration has already taken place, both UAs can access the proxy without additional DNS queries, but taking advantage of their DNS caches



Problem 7

- **If two SIP users have the following URI correctly registered in their domain**
  - alice@ipv6.polito.it
  - bob@iptel.org

1. **Draw a diagram with all the messages exchanged between Alice and Bob, in oder to set up a call, including:**
   1. Possible auxiliary messages
   2. Messages sent by the proxies

Esercizio 7 - soluzione